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Food and Feeding of Deep-sea Redfish (*Sebastes mentella* Travin) in the North Atlantic

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Abstract

The food and feeding of deep-sea redfish (*Sebastes mentella* Travin) are described from stomach contents of 26 381 individuals analyzed on board commercial vessels in the Irminger Sea waters, from March to November 1996. Most of the stomachs had been everted (58.7%). The mean feeding intensity value through the period was 7.1%. The feeding intensity was higher in the months of least reproductive activity in each sex. The main natural prey were Copepoda, Euphausiacea, Mollusca, Decapoda and Myctophidae.

Crustacea dominated the deep-sea redfish diet in March and were more abundant in the diet of smaller individuals; the variety of food items preyed on increased with the length. The intense commercial fishing activity in the area was observed to have a direct influence on the diet composition. Waste products from on-board processing by the fishing fleet reached higher volume values in the adult diet of deep-sea redfish.

The comparison between Irminger Sea deep-sea redfish diet and Flemish Cap in the same year and month showed some composition differences.

Key words: feeding, Flemish Cap, food, Irminger Sea, redfish

Introduction

The deep-sea redfish (*Sebastes mentella* Travin) is one of the most important commercial species exploited in the Irminger waters. In the international waters of Reykjanes Ridge Area, an international pelagic fishery targets this species. A considerable number of vessels carry out commercial fishing activity mainly during the period from April to June. The catches reached 59 776 tons in 1994 and 42 986 tons in 1995 (Anon., MS 1995).

Knowledge of food and feeding patterns of exploited species is a very important aspect of multispecies management, since the quality and quantity of food intake by fish are known to be important factors for their growth, maturity and changes in fecundity. It is also known that intense commercial fishing activity in the open sea can produce changes in the diets of fish, since offal from fish-processing has been found in a number of stomachs of fish sampled in the area where the fleet was operating (Rodríguez-Marín *et al.*, MS 1993, MS 1994, 1995).

There are no recent studies on the food of *Sebastes mentella* for the Reykjanes Ridge Area (Jones, 1970). Furthermore, diet data (Magnússon *et al.*, MS 1994, MS 1995) and biological observations (Reynisson *et al.*, MS 1995) from research survey sampling cannot correspond to the fish diet found under fishery conditions. The aim of this paper is to examine the food and feeding of the deep-sea redfish in the Irminger Sea under fishing conditions and analyse the fishery influence in the diet. The differences in food by sex, by length and the seasonal variations in the period March to November and the condition factor by sex are also examined. A comparison of the diets of Irminger Sea and Flemish Cap deep-sea redfish is also made.

Material and Methods

The survey samples were taken on board by scientific observers belonging to the Studies Program at the Instituto Español de Oceanografía, on the Spanish fishery targeting deep-sea redfish in 1996. The study area was the international waters of the Irminger Sea, and the material was taken from the Spanish fishery targeting deep-sea redfish in ICES Div. XII and XIVb, Reykjanes Ridge Area, where the international commercial fleet operates (Fig. 1). During the period March to November 1996, three on-board scientific observers under the Spanish program took biological samples of *Sebastes mentella*. In each haul, about 100 individuals were examined. Each specimen was measured to the nearest cm, sexed and stomach content examined. Fish whose stomachs were everted or contained prey ingested in the fishing gear were discarded. The volume (in cc) of each stomach content was quantified with a trophometer (Olaso, 1990) and the percentage with respect to this volume and number of each prey were also noted for the period March to August. Prey were identified to the lowest possible taxonomic level.

For stomach content analysis, predator length, sex and month were taken into account. With regard to predator length, 6 length groups with a range of 5 cm were established.

Information on *Sebastes mentella* from Flemish Cap, Northwest Atlantic (NAFO Div. 3M) corresponding to July 1996 was provided by A. Vázquez (pers. comm., Instituto Investigaciones Marinas, (IIM-CSIC), Vigo 1997) and on biological data by E. Rodríguez-Marín (pers. comm., Institutol Espanol de Oceanografia (IEO), Santander 1997). This made it possible to make some comparisons between the Flemish Cap and Irminger Sea populations.

To evaluate the importance of stomach content, the following indices were used:

Frequency of occurrence (*FO* as percentage):

$$FO = n_p/N_t*100,$$

where n_p is the number of stomachs with a specific prey, and N_t is the total number of stomachs containing food analyzed.

The frequency of occurrence method was used to characterize fish feeding; only stomachs containing food were used for estimation (Kennedy and Fitztmaurice, 1972). This method does not give quantitative information, but is efficient and requires a minimum of apparatus, giving a somewhat qualitative picture of the food spectrum (Hyslop, 1980).

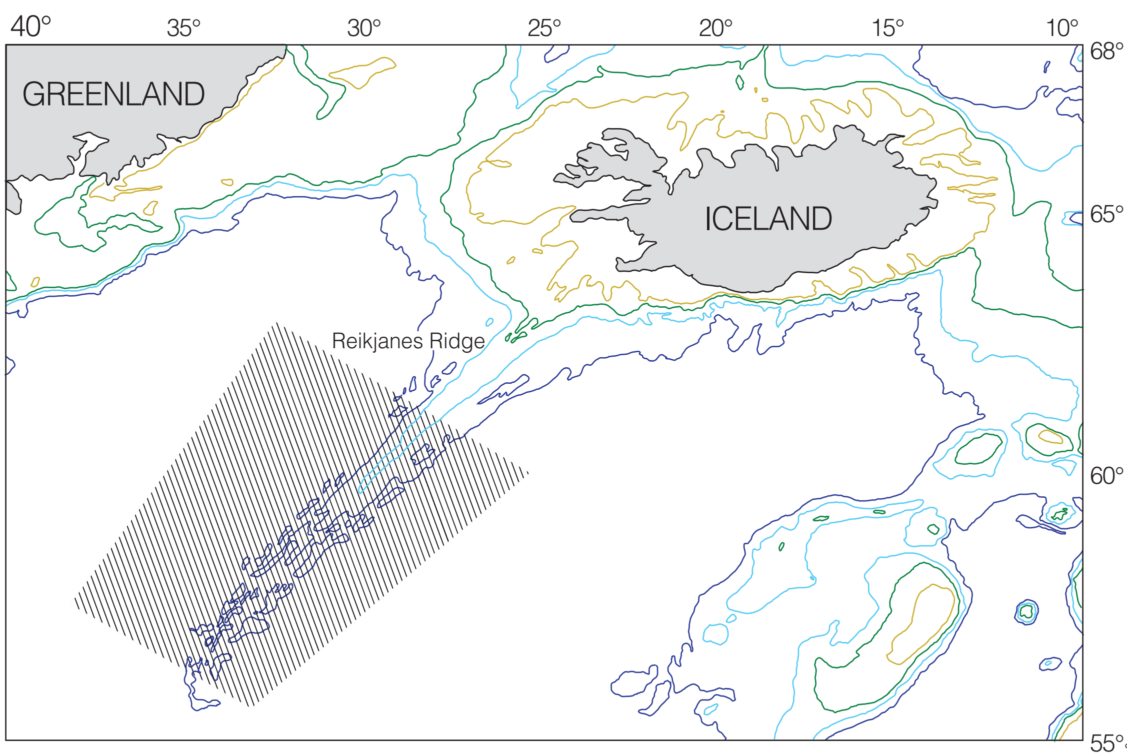

Fig. 1. Map showing the fishing zone of international commercial activity targetting *Sebastes mentella* in the Irminger Sea in the Reykjanes Ridge Area, March to November 1996.

Percentage by number (N):

$$N = n_p/N_t*100,$$

where n_p is the number of a specific prey, and N_t is the total prey number.

Percentage by volume (V):

$$V = v_p/V_t*100,$$

where v_p is the volume of a specific prey, and V_t is the total prey volume.

From these three measurements an Index of Relative Importance, IRI (Pinkas *et al.*, 1971), was calculated for each prey taxon, where possible, from $IRI = (N+V)FO$. Some unimportant prey were not taken into account.

To compare the diet of *Sebastes mentella* in Flemish Cap and the Irminger Sea in July 1996, IRI values were calculated for the main preys in each case.

The condition factor was studied with Fulton's expression:

$$\frac{W100}{L^3}$$

where W is total weight (g), and L is the length (cm) of the fish.

Maturity stages by sex were on sight estimates according to the following scale:

For males:

Stage I – Immature (throughout the year): gonads very small and translucent.
Stage II – Ripening: larger sized, white testes without sperm.
Stage III – Mature: gonads with sperm in the interior observed (when cut).
Stage IV – Spawning: gonads cream colour, and the sperm flow to exterior.
Stage V – Spent: flaccid gonads without sperm.
Stage VI – Recuperating: gonads similar in size to those at Stage II, without sperm and white cream colour.

For females:

Stage I – Immature: very small and cylindrical ovaries.
Stage II – Ripening-mature: larger, granular ovaries, yellow/orange and opaque eggs.
Stage III – Mature-fertilized: more developed ovaries, with bright yellow eggs.
Stage IV – Spawning: ovaries occupy every visceral cavity and yellow-green colour, and flow to exterior, the eyes of the larvae are evident.
Stage V – Post-spawning: large, flaccid ovary, without larvae, purple-blackish colour.
Stage VI – Recuperating: ovary similar in size to those at Stage II, yellow-purple colour.

Comparing this scale given as Stages I to VI to that of the *Study Group on redfish stocks* (Anon., MS 1993), the correspondence between both are as follows:

Stage I – corresponds to "Juvenile".
Stage II – corresponds to "ripening".
Stages III and IV – corresponds to "spawning".
Stages V and VI – corresponds to "spent".

Results and Discussion

A total of 26 381 individuals were examined. Table 1 shows the number of individuals sampled by month. Most of the studied specimens, 15 488 (58.7%), had everted stomachs or empty stomachs, 10 120 (38.4%). The everted stomachs were discarded from the analysis. The length frequencies of deep-sea redfish containing food and analyzed are shown in Fig. 2.

Feeding intensity. The mean of feeding intensity was 7.1% in the period studied. By month, the maximum value was reached in March (12.9%), somewhat higher than that reported by Magnússon *et al.*, MS (1995) for the same month of the previous year (10%). The minimum value corresponds to October, 1.3% (Table 1).

Feeding intensity in this species may prove to be distorted in view of the high number of everted or regurgitated estomachs (Pedersen, 1994). However, these results correspond with those by Jones (1970), where the maximum value of intestinal contents in volume was obtained during summer and November, with a considerable reduction in October.

Albikovskaya *et al.*, (1993) for *Sebastes mentella* on Flemish Cap found the most intensive

TABLE 1. Stomach condition of *Sebastes mentella* given as percentage of total sampled in Irminger Sea area, March through November 1996.

Month	% Full	% Empty	% Everted	Total Number
March	12.96	47.25	39.78	1 674
April	2.53	52.71	44.77	5 303
May	1.84	34.30	63.85	8 734
June	4.80	35.65	59.55	1 896
July	2.64	20.71	76.64	1 931
August	2.11	29.72	68.16	2 271
September	1.54	39.25	59.22	2 018
October	1.30	41.83	56.86	1 690
November	2.08	33.33	64.58	864
Total Number	773	10 120	15 488	26 381

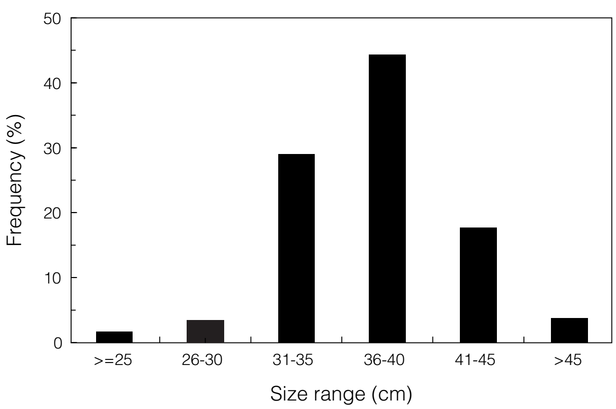

Fig. 2. Size range distribution of individual *Sebastes mentella* in the Irminger Sea, March–November 1996, with food in the stomach.

feeding during June–August, with a lower feeding intensity in winter and early spring period, this latter finding being attributed to the very low plankton biomass. Similar results were obtained in other studies on Flemish Cap (Konstantinov *et al*., 1985; Lilly, 1987).

In feeding studies on *Sebastes* spp. off West Greenland, the highest percentage of empty estomachs was noted in winter and of fullness estomachs in spring (Pedersen *et al*., 1993).

Other species of *Sebastes* (*Sebastes caurinus* and *Sebastes maliger*) in Saanich Inlet (British Columbia, Canadá), showed a high food consumption in winter, particularly in *S. caurinus*. This was attributed to covering energy requirements for the reproductive cycle; despite, the feeding intensity of *S. maliger*, this was higher in spring and summer (Murie, 1995).

Diet composition. Table 2 shows the presence of each diet component by month. Diversity was greater in March, decreasing through the period considered. The relative importance of prey is shown in Table 3. The most important prey were:

Copepoda FO = 11.6%, V = 1.2%, IRI = 1582.5
Mollusca Decapoda FO = 15.4%, V = 8.9%, IRI = 736.8
Euphausiacea FO = 17.1%, V = 3.6%, IRI= 1361.9
Myctophydae FO = 6.3%, V = 3.3%, IRI = 220.3
Offal from fish-processing FO = 40.6%, V = 72.5%

Deep-sea redfish is acknowledged to be a typical plankton-eater (Konstantinov *et al*., 1985; Lilly, 1987). In the Northwest Atlantic, copepods, pelagic amphipods and euphausiids constitute the main food items in July–August (Albikovskaya *et al*., 1993).

Jones (1970) noted that the main components of the diet of *Sebastes mentella* are copepods, hyperiids, euphausiids and chaetognaths with the rare presence of fish, and cannibalism was occasional.

The differences in the results here compared with those by Magnússon *et al*., MS (1995) are striking, since they showed a scarcity of copepods, chaetognaths and scyphozoa in March, whereas in our case, it was precisely in this month when this prey appeared. Both studies, however, coincide over the main prey, and also they found fish remnants.

Although offal from fisheries activity is a highly uncommon component in feeding studies, its

TABLE 2. Presence of food items found in *Sebastes mentella* stomachs sampled from March to November 1996 in Irminger Sea area.

Food taxa	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
CRUSTACEA									
Amphipoda									
Hyperiidae	*			*					
Copepoda	*								
Decapoda									
Natantia									
Pandalidae	*		*	*	*				
Others Natantia	*	*	*		*	*	*	*	*
Euphausiacea	*	*	*						
Crustacea unidentified					*	*	*	*	*
MOLLUSCA									
Cephalopoda	*	*	*						
Decapoda	*	*	*	*	*	*	*	*	*
Octopoda	*		*		*				
PISCES									
Myctophidae	*	*	*	*	*		*	*	
Chauliodus sloani			*	*	*	*	*		
Notolepis rissoi	*	*	*			*	*		
Nemichthys scolopaceus		*	*		*				
Pisces unidentified	*	*	*	*		*	*	*	*
Fish larva	*								
OTHER INVERTEBRATES									
Chaetognata	*								
Cnidaria (Scyphozoa)	*		*		*	*	*		
OFFAL	*	*	*	*	*				*

important contribution has, however, recently been cited for other species (Rodríguez-Marín *et al*., MS 1993, MS 1994, 1995).

Comparing the diet of the redfish of Flemish Cap with the Irminger Sea, it was found that the Copepoda were the main prey on Flemish Cap, whereas in the Irminger Sea the Mollusca Decapoda were the dominant prey item in the diet (Table 4).

In studies on Flemish Cap carried out during summer on three species of *Sebastes* distributed there (*S. mentella*, *S. marinus* and *S. fasciatus*), it was shown that the main prey were crustaceans (copepods, hyperiids, amphipods and euphausiids), but out of the three species, *Sebastes mentella* presented less zooplanktonic organisms (copepods and chaetognaths) in stomachs contents. This was attributed to the species being in a more pelagic habitat with a wider vertical distribution. Besides presenting a wider prey espectrum, it was the only species which preyed upon cephalopods (Rodríguez-Marín, MS 1995; Rodríguez-Marín *et al*., MS 1994).

At West Greenland, the main prey of *Sebastes* spp consisted of crustaceans (mysids, copepods, hyperiids, euphausiids and shrimps, mainly *Pandalus borealis*), very few fish (small redfish) and cephalopods (Pedersen and Riget, MS 1991).

Murie (1995), for *Sebastes caurinus* and *Sebastes maliger,* found a more varied diet, with a greater importance of demersal crustaceans and fish; both species mainly consumed pelagic fishes and pelagic crustaceans (euphausiids and mysids) and demersal crustaceans, where, in general, *S. caurinus* presented a higher consumption of fishes, while *S. maliger* consumed crustaceans. However, it should be taken into account that these comprise important diet components considering their frequency of occurrence, while fish are the most important prey by weight, for both species.

Differences in the IRI between the Irminger Sea and Flemish Cap. Comparing the IRI value from the Flemish Cap with the value for the Irminger Sea, from July onward, clear differences

TABLE 3. Percentage frequency of ocurrence (FO) and volume (VOL) of food items, and their index of relative importance (IRI) in *Sebastes mentella*, in the Irminger Sea, 1996.

	FO(%)		TOTAL		
Food Items	Males	Females	FO(%)	VOL(%)	IRI
CRUSTACEA					
Amphipoda					
Hyperiidea	9.3	1.7	5.8	0.5	166.3
Copepoda	19.7	2.0	11.6	1.2	1582.5
Decapoda					
Natantia					
Pandalidae	1.9	0.6	1.3	0.3	4.7
Other Natantia	5.0	2.6	3.9	1.2	53.0
Euphausiacea	27.1	5.1	17.1	3.6	1361.9
Crustacea unidentified	2.1	3.7	2.9	0.3	47.6
MOLLUSCA					
Cephalopoda					
Decapoda	11.6	1.9	15.4	8.9	736.8
Octopoda	0.7	0.0	0.4	0.7	–
PISCES					
Myctophidae	7.6	4.8	6.3	3.3	220.3
Chauliodus sloani	1.0	2.3	1.6	1.6	18.8
Notolepis rissoi	1.4	3.4	2.3	1.0	12.0
Nemichthys scolopaceus	1.0	0.0	0.5	1.7	7.0
Pisces unidentified	6.7	5.7	6.2	1.9	–
Fish larva	0.2	0.0	0.1	0.0	0.0
OTHER INVERTEBRATES					
Chaetognata	2.9	0.6	1.8	0.1	–
Cnidaria (Scyphozoa)	2.4	2.6	2.5	1.6	–
OFFAL	31.1	52.0	40.6	72.5	–
Number Individuals	421	352	773	657	308

TABLE 4. Comparation of index of relative importance (IRI) of main food items found in stomach of *Sebastes mentella* for July 1996 on Flemish Cap and in the Irminger Sea area.

	IRI	
Food Items	Flemish Cap	Irminger Sea
CRUSTACEA		
Amphipoda		
Hyperiidea	735.06	0
Copepoda	3 481.78	0
Decapoda		
Natantia		
Pandalidae	405.40	3.60
Other Natantia	1.50	366.70
Euphausiacea	629.49	0
Mysidacea	312.68	0
Crustacea unidentified	2.96	637.05
MOLLUSCA		
Cephalopoda		
Decapoda	8.68	3 494.70
PISCES		
Myctophidae	88.19	8.91
Nemichthys scolopaceus	0	55.01
Number Individuals	277	42

are noted. On the Flemish Cap, the most important prey were: Copepoda (3481.8), Hyperiidea (735.1) and Euphausiacea (629.5), followed by Pandalidae and Mysidacea. All these gave insignificant values in the Irminger Sea, the most important prey being Mollusca Decapoda (3494.7), unidentified Crustacea (637.1) and Other Natantia (366.7). All these species hardly contributed to the Flemish Cap redfish diet (Table 4). These differences highlighted important ecological dissimilarities between areas, although some of the differences in diets may have been due to the difference in sampling method, notably bottom trawling on Flemish Cap as opposed to pelagic trawling in the Irminger Sea. A further reason for these dissimilarities may be the number of individuals sampled from the catch and the different sized meshes used in each case (Table 4).

Season. The Irminger Sea deep-sea redfish diet composition studied by month and sex (Table 5 and Fig. 3), showed that some food items had clear seasonal patterns, diversity diminishing in autumn and winter. Crustacea were dominant in the spring diet, and later disappeared from the diet. The Mollusca Decapoda increased their presence in the summer-autumn period and the viperfish (*Chauliodus sloani*) in summer. Jones (1970) also found considerable seasonal variation in prey; euphausiids predominating the first half of the year, copepods in summer and hyperiids in autumn.

This same circumstance was observed in other areas and species of this genus. On Flemish Cap, copepods predominated in the diet of *Sebastes mentella* during the summer, and *Pandalus borealis* increased in winter (Albikosvkaya, 1993).

At West Greenland, hyperiids predominated in the diet of *Sebastes* spp. in summer and autumn, and *P. borealis* throughout the year (Pedersen *et al.*, 1993).

In British Columbia waters, seasonl variation was not as pronounced in the diet of *Sebastes caurinus* as in the above cases, demersal crustaceans being the most important prey in all seasons,

TABLE 5. Percentage frequency of ocurrence of food items given by sex and months for *Sebastes mentella* in Irminger Sea, March through November 1996.

	MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV	
Food Items	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
CRUSTACEA																		
Amphipoda																		
Hyperiidea	21.2	15.2	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copepoda	45.1	21.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decapoda																		
Natantia																		
Pandalidae	2.2	0.0	0.0	0.0	1.6	1.0	5.4	1.9	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Natantia	6.5	3.0	1.4	1.6	1.6	0.0	0.0	0.0	26.1	21.4	0.0	0.0	0.0	0.0	0.0	0.0	11.1	11.1
Euphausiacea	59.2	39.4	5.5	1.6	1.6	3.1	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crust.unidentified	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	7.1	17.7	12.9	0.0	13.8	30.8	33.3	11.1	0.0
MOLLUSCA																		
Cephalopoda																		
Decapoda	3.8	9.1	6.9	1.6	1.6	1.0	5.4	1.9	39.1	57.1	64.7	67.7	100	55.2	61.5	44.4	44.4	77.8
Octopoda	0.5	0.0	0.0	0.0	1.6	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PISCES																		
Myctophidae	9.8	9.1	9.6	11.5	6.4	1.0	2.7	5.6	4.4	0.0	0.0	0.0	0.0	10.3	7.7	0.0	0.0	0.0
Chauliodus sloani	0.0	0.0	0.0	0.0	1.6	0.0	5.4	1.9	4.4	10.7	0.0	3.2	0.0	10.3	0.0	0.0	0.0	0.0
Notolepis rissoi	0.5	0.0	1.4	1.6	4.8	1.0	0.0	0.0	0.0	0.0	5.9	22.6	0.0	10.3	0.0	0.0	0.0	0.0
N. scolopaceus	0.0	0.0	1.4	0.0	1.6	0.0	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pisces unidentified	4.4	6.1	9.6	4.9	7.9	7.1	10.8	1.4	0.0	0.0	17.6	0.0	0.0	10.3	7.7	33.3	0.0	11.1
Fish larva	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTROS INVERT.																		
Chaetognata	6.5	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cnidaria (Scyphozoa)	2.2	0.0	0.0	0.0	0.0	2.0	0.0	0.0	26.1	17.9	0.0	3.2	0.0	3.5	0.0	0.0	0.0	0.0
OFFAL	4.9	18.2	67.1	75.4	68.2	85.7	73.0	85.2	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0
Number Individuals	184	33	73	61	63	98	37	54	23	28	17	31	2	29	13	9	9	9

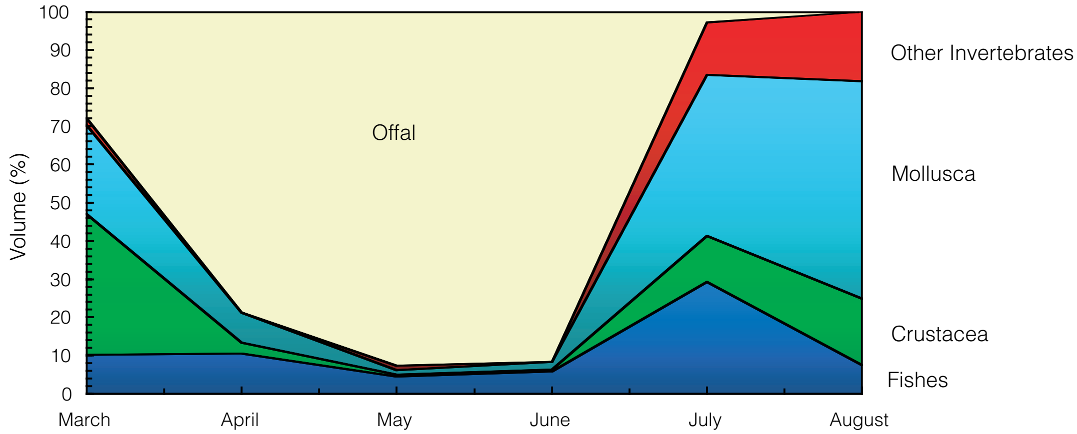

Fig. 3. Volumetric index (%) of prey types and offal found in the stomachs of *Sebastes mentella* in the Irminger Sea, March to November 1996.

and pelagic crustaceans being slightly more important in spring and summer. In the case of *Sebastes maliger*, pelagic crustaceans were more important in spring and summer, demersal crustaceans increased in autumn and decreased in winter, and pelagic fishes increased in winter for both species (Murie, 1995).

The presence of offal in the diet of *Sebastes mentella* in the Irminger Sea, consumed from at-sea commercial fish processing discards, reached its maximum value in April–June, which coincided with the period of most fishing activity (Fig. 4). Comparison of the fishing yield (kg/h) with the frequency of occurrence of offal (given as a percentage) showed a clear correspondence of both indices in seasonal patterns (Fig. 4). A similar situation was noted for Greeland halibut (*Reinhardtius hippoglossoides*) in Flemish Pass (Rodríguez-Marín *et al.*, MS 1993). The presence of offal in the deep-sea redfish diet in this area has not been reported in previous studies based on data taken from surveys (Jones, 1970; Magnússon *et al.*, MS 1994).

Sex and length. By sex, the high frequency of occurrence values of Copepoda, Euphausiacea and Mollusca Decapoda in males relative to females in the Irminger Sea samples was noted (Table 3). The frequency of occurrence and the volume (given as a percentage) of Crustacea decreased as the deep-sea redfish size increased (Table 6, Fig. 5). The Cephalopoda, the Pisces and particularly the offal values increased frequency in the diet as length of deep-sea redfish increased. The sharp fall in the presence of fishes in the stomach contents at deep-sea redfish lengths over 45 cm was particularly notable. The higher values of Euphausiacea in volume were observed in individuals of less than 25 cm. Crustacea, in general, almost disappeared from the diet at deep-sea redfish sizes greater than 45 cm. Mollusca Decapoda appeared in the diet from 26 cm, and so too the discards of processed fish (offal) which increased in volume with the increase in size (Fig. 5).

In Flemish Cap the diet of deep-sea redfish lengths over 20 cm comprised euphasiids, chaetognaths, shrimps and little fishes, and cannibalism was not frequent, although this had increased in the recent years and in the smaller sizes, the diet was mainly hyperiids (Albikovskaya, 1993). In general, it was observed that the greater the *Sebastes*

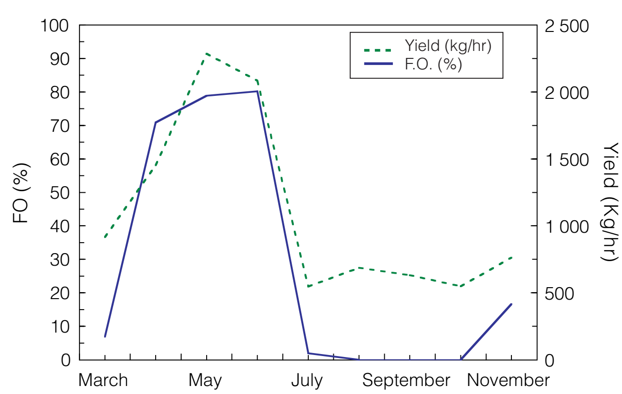

Fig. 4. Frequency of ocurrence (F.O.) of offal (%) and fishery yield (kg/hr) of *Sebastes mentella* in the Irminger Sea, March to November 1996.

TABLE 6. Frequency of ocurrence (%) by length groups of *Sebastes mentella*, in the Irminger Sea, 1996.

Food Items	Length Group of *Sebastes mentella* (cm) < = 25	26–30	31–35	36–40	41–45	>45
CRUSTACEA						
Amphipoda						
Hyperiidea	7.7	11.1	5.4	7.9	1.5	0.0
Copepoda	23.1	29.6	20.1	9.6	0.7	0.0
Decapoda						
Natantia						
Pandalidae	0.0	0.0	1.3	1.5	0.7	3.4
Other Natantia	7.7	0.0	1.3	6.1	2.2	0.0
Euphausiacea	84.6	37.0	21.4	16.3	3.6	6.9
Crustacea unidentified	0.0	0.0	4.5	3.5	0.0	0.0
MOLLUSCA						
Cephalopoda	0.0	0.0	0.4	0.3	0.0	10.3
Decapoda	0.0	11.1	15.2	19.5	10.2	3.4
Octopoda	0.0	0.0	0.4	0.6	0.0	0.0
PISCES						
Myctophidae	7.7	3.7	6.3	7.0	6.6	0.0
Chauliodus sloani	0.0	3.7	0.4	1.7	2.9	0.0
Notolepis rissoi	0.0	0.0	1.8	3.5	1.5	0.0
Nemichthys scolopaceus	0.0	0.0	0.4	0.3	1.5	0.0
Pisces unidentified	7.7	11.1	7.6	4.7	6.6	6.9
Fish larva	0.0	0.0	0.0	0.3	0.0	0.0
OTHER INVERTEBRATES						
Chaetognata	7.7	0.0	3.1	1.7	0.0	0.0
Cnidaria (Scyphozoa)	0.0	0.0	1.8	2.9	3.6	0.0
OFFAL	0.0	18.5	34.4	35.9	63.0	75.9
Number Individuals	13	27	224	343	137	29

mentella length, the greater the prey length, a fact corroborated by other studies, as in Rodríguez-Marín *et al.*, MS (1994). They noted that individuals with lengths over 20 cm exclusively fed crustaceans, mainly copepods, followed by hyperiids, mysids and chaetognaths, and as size increased, so too did the hyperiids and mysids. In the large sizes, small planktonic crustaceans decreased and Crustacea Decapoda and fish, mainly Myctophids, increased (and also *Serrivomer beani* for *S. mentella*, unlike the other two species of *Sebastes* distributed in the area).

In West Greenland, this behaviour in *Sebastes* spp was similar, small crustaceans have less presence as the size of redfish increases, and the presence of *P. borealis* increases (Pedersen *et al.*, 1993).

Other species of *Sebastes* also show different preferences depending on the size, as in the cases above. In the case of the small sizes of *Sebastes caurinus*, demersal crustaceans predominated, whereas in the case of the intermediate and large sizes, pelagic fishes predominate, both cases taking the frequency into account, since by volume, pelagic fishes predominate in all sizes. In the small sizes of *Sebastes maliger*, however, pelagic crustaceans appear more frecuently, and in the intermediate and large sizes, fish appear (less than in *Sebastes caurinus*); and generally, all sizes present demersal crustaceans (Murie, 1995)

The main difference in the diet according to this study in terms of others, lies in the high presence of offal in the stomach contents. Fishing activity, and more especially, the offal from fishing activity, seems to be an important influence on the diet of the adult fraction of the population. This was particularly observed in individuals of over 35 cm, as their incidence increased with increased deep-sea

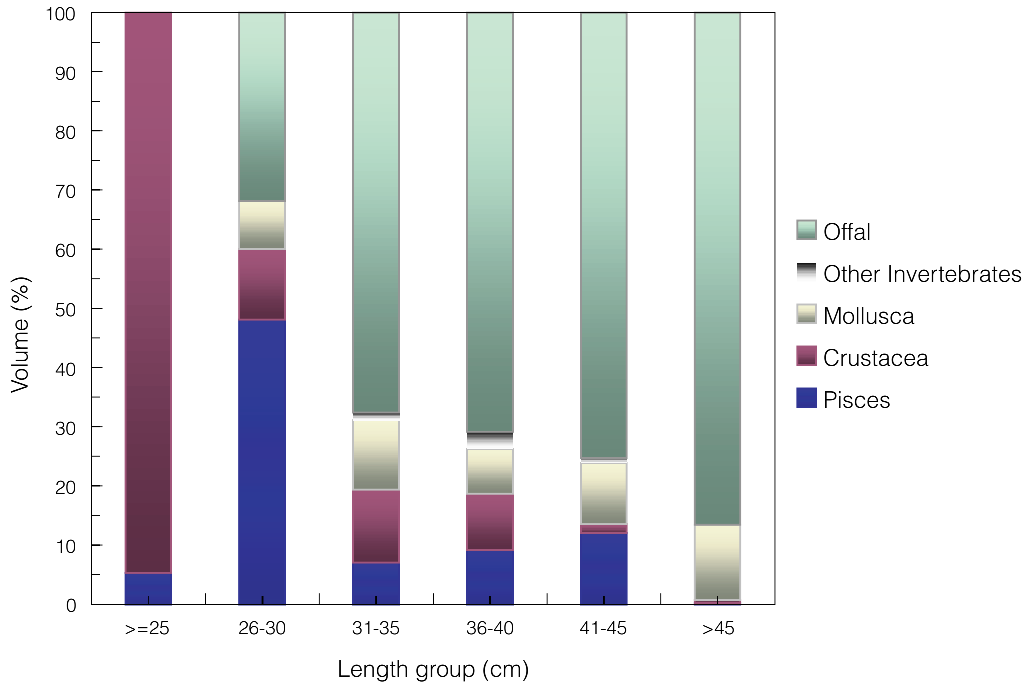

Fig. 5. Volumetric index (%) of main prey and offal for length groups of *Sebastes mentella* in the Irminger Sea, March–November 1996.

redfish length groups (Table 6). This preference in the larger sizes for this food item has also been observed in other species (Rodríguez-Marín *et al.*, MS 1993, MS 1995).

No relationship was observed between the sex ratio and the feeding intensity (Fig. 6), although there was a relationship between the feeding intensity and the reproductive cycle, as noted in other studies (Murie, 1995). It was noted that the higher values of frequency of occurrence occurred in the stages of post-spawning and sexually inactive stages of deep-sea redfish, in both sexes (Fig. 7).

Condition factor. Although weight calculation of individuals on board commercial vessels is inaccurate (Gutreuter and Krozoska, 1994), the value of the condition factor was estimated using the Fulton expression. The mean value for the period March–August was similar by sex at 1.19 in males and 1.18 in females. Some variation was observed by month, with the minimum value corresponding to June 1996 (Table 7). The total value of the condition factor obtained was 1.19 ± 0.14.

The mean of the condition factor calculated from the Flemish Cap survey (NAFO Div. 3M) in July 1996 on a sample of 1 472 individuals was 1.43 ± 0.17. This was greater in females (1.46 ± 0.22) than in males (1.41 ± 0.09). When comparing these results, we should take into account the fact that the length range of the individuals sampled on Flemish Cap was from 11 to 45 cm, whereas in the Irminger Sea, this was from 22 to 49 cm.

Studies of *Sebastes mentella* diet in the different areas shows that it is a planktonic-eater, but with differences in the proportions of the various food components present in the diet, depending on the season and geographical distribution of the prey species (Jones, 1970; Pedersen, 1994). Furthermore, the natural food of a species may be changed to a large extent when it is subjected to the conditions caused by fisheries activity. So, this study notes how the habitual food components are displaced, showing a preference for the processing offals from fisheries activity, mainly in the larger sized individuals, altering the habitual diet substantially, possibly due to the high availability and ease in catching, and due to the high concentration of this species in certain months of the year, and the high number of vessels operating on these concentrations of deep-sea redfish.

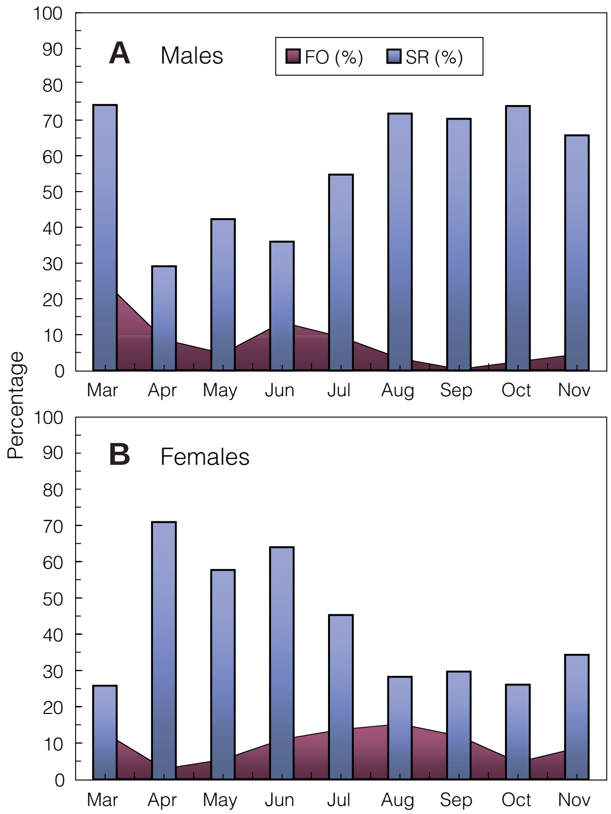

Fig. 6. Sex ratio (SR) in the catches and frequence of ocurrence (FO) by sex of *Sebastes mentella* in the Irminger Sea, March to November 1996.

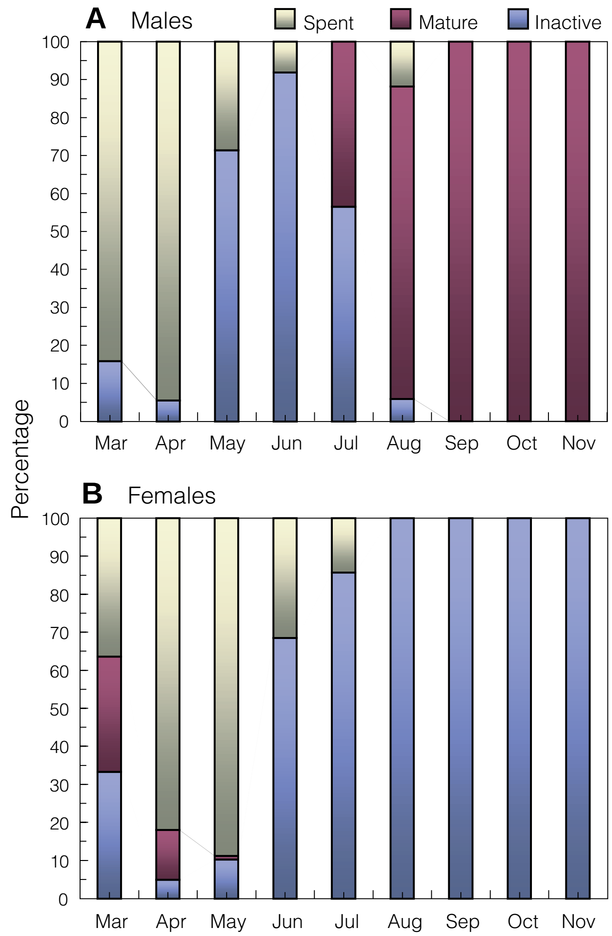

Fig. 7. Maturity stages of adult *Sebastes mentella* in Irminger Sea, observed through the study months March to November 1996: Inactive Stage I and II, Mature Stage III and IV, Spent Stage V and VI.

To gain knowledge of the development in diet composition and food in general, it is necessary to continue studies all year round, combining data taken from scientific surveys with data from commercial fishing vessels. In this manner, it would also be possible to determine the influence of fishing activity on the food of the deep-sea redfish.

Summary

- The food intensity of *Sebastes mentella* in Irminger Sea shows seasonal variations, with a maximum in spring and minimun in autumn, which appears to be related to the reproductive cycle.
- The diet of this species corresponds to pelagic habitat in which it develops, with seasonal variations in the occurrence of prey and consumption of them. Cannibalism was not noted.
- Differences in the diet of this species have been found for the same month in the year in different areas, as observed when comparing the results on the Irminger Sea with those of Flemish Cap.
- The presence of offal from commercial fishing activity comprises an important percentage of the diet of individuals over 45 cm, and their importance appears to be related to the intense fishery activity in the area.

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TABLE 7. Condition factor value (%) by sex of *Sebastes mentella* in the Irminger Sea, March–August 1996. The weight (kg) used is the live weight less its stomach content.

Month	Males	Females	Total
March	1.20 ± 0.10	1.18 ± 0.11	1.19 ± 0.10
April	1.19 ± 0.13	1.22 ± 0.12	1.21 ± 0.12
May	1.20 ± 0.11	1.18 ± 0.12	1.20 ± 0.11
June	1.06 ± 0.09	1.06 ± 0.11	1.06 ± 0.10
July	1.32 ± 0.07	1.32 ± 0.12	1.32 ± 0.10
August	1.36 ± 0.09	1.31 ± 0.08	1.40 ± 0.08
Number Individuals	372	274	646

and Enrique Rodríguez-Marín for information on food, both sources regarding Flemish Cap *Sebastes mentella*.

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